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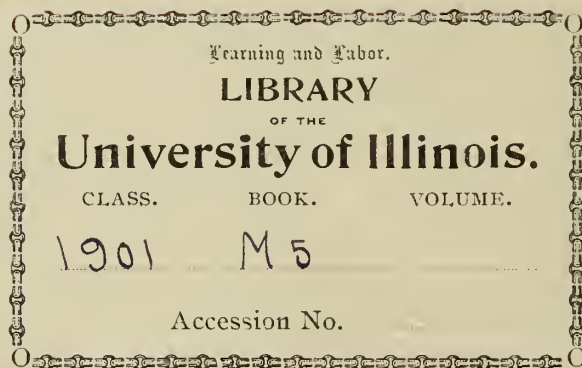
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Variations in Chlorine  
in the Well Waters  
of Champaign and Urbana

Chemistry

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The Variations in Chlorine in the Well Waters of  
Champaign, Urbana and Vicinity

. . . BY . . .

RUTHERFORDE THOMAS MILES

THESIS

FOR THE

Degree of Bachelor of Science in Chemistry

IN THE

COLLEGE OF SCIENCE

UNIVERSITY OF ILLINOIS

1901



1901

MS

UNIVERSITY OF ILLINOIS

May 31<sup>st</sup>, 1901

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Author: Thomas Miles

ENTITLED

THE VARIATIONS IN COMPOSITION OF THE LARVAE OF COLEOPTERA

AND VICINITY

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF

BACHELOR OF SCIENCE IN THE COLLEGE OF SCIENCE

D. S. in Chemistry

HEAD OF DEPARTMENT OF

Arthur W. Palmer

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## VARIATIONS OF CHLORINE IN CHAMPAIGN, URBANA AND VICINITY.

The presence of chlorine in water in an abnormal quantity is considered of vast importance as an indication of contamination by sewage. By an abnormal quantity of chlorine we mean the chlorine present which does not have as its source the salt deposits of the earth, the inorganic salts of the soil, or the salt from the sea, or salt lakes. Normal chlorine thus may be construed to include all chlorine present in water due to natural conditions, while all Cl content due to filtrations from oxidized organic matter in the earth, from surface water containing organic matter washed into wells because of favorable stratifying of the surrounding earth, may be considered as abnormal chlorine, or that, due to contamination or external influences.

Chlorine may be present in water in an amount greatly exceeding the normal chlorine content and yet not be an indication of contamination. The chlorine of course is present in combination with sodium usually sodium or potassium - in the majority of cases sodium - whether it is present because of contamination, or as normal chlorine. The fact that the chlorine may be much larger than that of normal chlorine and yet not be an evidence of polluted water is true because organic matter which contains chlorine may find its way into the earth, and be completely oxidized there, the chlorine filtering into the water supply in solution in water from the surrounding earth. In such a case - according to the Massachusetts State Board of Health Report of 1890 (I could not learn the name of the man who did the work) the water from the earth which finds its way into a stream or other water supply may possess a large chlorine content and yet be purer than the water source into which it flows and which contains only a minute amount of chlorine. From data studied in the same report we learn that in Massachusetts, the amount of normal chlorine ranges all the way from a mere trace to eight or ten and even fifteen parts per million. Mr. Koch, of the University of Illinois, made a study which is substantially the same as the above, concerning Illinois wells ranging in depth from 10 or 12 to 50 or 60 feet - in a lecture to a class in Sanitary Analysis of water in the fall of 1900.

The cases in which these figures do not hold true are due to salt deposits or salt from the sea and are discussed elsewhere in this paper.

It was learned by the above mentioned Mass. State Board of Health



that the quantity of chlorine present in the ordinary water sources varied greatly (in Massachusetts) at different seasons of the year. We have a right to assume that this fact is true in this locality because of reasons assigned for those variations in chlorine content; which follows:-

"During the dry season, when the earth surrounding a well is almost completely free of surface water, there is little danger of contamination (excepting that gained by organic impurities being washed into the well by water from the pump) by the usual way - that of rain flushing the earth and causing the well to become a cess-pool. If the drought is longer continued the chlorine content will decrease noticeably - but during this season organic matter of every sort, whether from privy vaults, kitchen slops or other refuse is collecting in quantity and when rains come it is washed into shallow wells with very little hindrance from open porous earth.

It seems to be the consensus of opinion that barn-yards and water closets situated on a lower level than adjacent wells can have no contaminating influence on said well, because surface drainage would tend to carry such waste away. But underground strata may slope in just the opposite direction from that of the surface and hence render erroneous any assumption that the well must be uncontaminated because of external surface conditions. A certain amount of the semi-liquid matter which soaks into the earth gradually carried toward the well, which is sure to be contaminated by it unless prevented by a stratum of earth which is so dense as not to permit of the passage of liquids. Even in this case, if <sup>the</sup> well is not a tubular one, the chances for contamination are not decreased, for if the well is dug, the stratum of rock or blue clay may slope toward the well, and acting almost <sup>as</sup> a sewer, literally pour the impure water into the water of the well.

If a well is protected by a good cover and is situated at some distance from barns or other outhouses harboring impurities, and is in a grass plot which slopes away from the top of the well, the uninitiated may be forgiven for thinking that the water in their well "is the best in the State of Illinois." - but no excuse, except for profound ignorance, can be offered for persons who thoughtlessly or wantonly throw slops about the surface of a poorly covered well, whose top is lower than the surface of the surrounding ground, who have the covers of such shallow wells open so that the slops may be washed directly into the well on the occasion of every shower of rain. The same class of persons place privy vaults and barns on the highest part of the lot and only a few feet from the well, which then might better be termed a cess-pool. As an instance of the extreme ignorance or carelessness of a majority of the uneducated class I will cite the following case, which came within my experience while doing



work in Sanitary analysis of water during the fall of 1900=- On west  
Stoughton street in Urbana, Illinois I took a sample of water from a well  
which was twelve feet in depth and fitted with an old wooden cask of the  
largest size. The cover of the well was formed of old pine boards, one  
inch in thickness and rotted so badly that holes of three or four inches  
were numerous. The earth had been thrown out, and sloped gradually out-  
ward and upward from the dilapidated cover to a distance of some twelve  
or fifteen feet in every direction from the well. Quite a number of  
hens were feeding in this back yard, stopping occasionally to drink  
from a low wall of kitchen slops which had been placed (it almost seemed  
as a menace against the health of the community) on one corner of the old  
rotted cover of the well. Some twenty feet away and at the back of the  
lot a privy vault was situated which made its presence conspicuous even  
when not used. Farther toward the corner of the lot a small barn was lo-  
cated, the refuse from which gave evidence of having been collecting for  
several weeks or months. Litter of every sort was in profusion from  
pieces of food thrown out to the fowls and cats, to playthings belonging  
to the half-dressed, ragged, dirty children who were playing about the well  
and adjacent ground. The lady living in the adjoining house stated that  
the well had been dug four years ago and that the water had been analyzed  
and pronounced pure shortly after sinking the well. Two years ago one  
of her children had been afflicted with a severe case of typhoid malaria  
and the attending physician had condemned the well without resorting to  
the formality of a chemical, or sanitary analysis (I think he must have  
done so simply because of the unpardonably bad surroundings.) The lady  
of the house rejected the idea that the drinking water consumed could have  
any bearing on the sickness of her child, evidently thinking that a well  
"once good was always good." A ten minute explanation of the many causes  
of contamination which were so plainly in evidence, failed to convince her  
that the water in her well might be unwholesome for it was "clear, cold  
and tasted better than any water in the neighborhood". The above instance  
is only one of scores of similar displays of ignorance or carelessness  
as to the sanitary conditions surrounding the drinking water source. One  
lady on West Church Street in Champaign, Illinois, who had a well dug 11 feet  
deep and almost as badly surrounded as the one described above, averred  
that the "city water" (which has been proven pure beyond the question of  
a doubt) invariably made her sick and that she was in consequence unable  
to visit a certain good friend of hers who had only "city water" for  
drinking purposes for fear of being "thrown into cramps" as she expressed  
it.

Water examined from another well on West Stoughton Street, Urbana,  
showed a large chlorine content, almost as large in fact as that in the



well mentioned above, but its sanitary conditions were fairly good as evidenced by the amount of Urea and Albuminoids, Ammonia, Nitrates, Nitrites and Oxygen consumed - while the well described above contained water that was absolutely unfit for use. My conclusion concerning this difference was that the difference in quality of the water depended on the fact that the last named well was neatly fitted with an iron pump, had a good two inch cover on top of a wall of brick and cement which jutted out to a height some eighteen inches above the surface of the surrounding earth which sloped away from the well, and which was covered by a heavy bed of lawn grass, clean and well kept. The conditions and surroundings in the last case being such that no surface water could flush directly into the well, but must filter through the soil, while in the instance of the well first described there was no hindrance to the entrance of vast quantities of contaminating agencies. The reasons for this difference in organic impurity are set forth in Johnson's "How Plants Feed", He says:-

"When the albuminoids decay in the soil, associated with carbohydrates and humus, the final results of this alteration may be summed up as follows: 1. Carbon unites mainly with oxygen, forming carbonic acid gas which escapes into the atmosphere. With imperfect supplies of oxygen, as when submerged in water, carbonic oxide and marsh gas are formed, a portion of carbon remains as humus. 2. Hydrogen, for the most part, combines with oxygen yielding water. In deficiency of oxygen some hydrogen escapes as marsh gas. If humus remains hydrogen is one of its constituents. 3. Nitrogen always unites to a large extent with hydrogen, yielding ammonia which escapes as gaseous carbonate in considerable quantity, unless from presence of carbohydrates such humus is formed in which case it may nearly or entirely be retained by the latter. Professor Way, in his investigation on the "Power of Soils to absorb manure" describes the following remarkable experiment: Three quantities of fresh urine of 2000 grains each were measured out into similar beakers. With one portion, its own weight of sand was mixed, with another, its own weight of white clay, the third being left without admixture of any kind. When smelt immediately after mixture, the sand appeared to have had no effect, while the clay mixture had entirely lost the smell of urine. The three beakers were covered lightly with paper and put in a warm place, being examined from time to time. In a few hours it was found that the urine containing the sand had become slightly putrid; then followed the natural urine, but the portion with which clay had been mixed did not become putrid at all, and after seven or eight weeks had elapsed it had only the peculiar smell of fresh urine, without the slightest putridity. The most soluble elements of manure are the organic ammoniacs, chlorides, urates, nitrates and nitrites.



The above mentioned organic matters are oxidized into harmless compounds in the soil. This ~~oxidation~~<sup>about</sup> is brought principally by the instability of salts like ferrous sulphate, which liberates oxygen and itself becomes the fixed oxide ( $\text{FeO}$ ). There is also a liberation of oxygen at the roots of such plants as clover, all field grasses, shrubbery and trees in their assimilation of microcosmic matters." As before stated a medium fine clay or loamy soil oxidizes or absorbs the greatest quantity, while very fine or exceedingly coarse soils are the least efficient in this regard, because the former does not allow the water to flow through at such a rate that all the impurities do not have time to be oxidized. However, no matter what the quality of the soil, if within a few yards of the well there is a barn-yard, a privy vault, a cess pool for domestic purposes and other outbuildings, as is often the case, the soil in close proximity must necessarily become laden with organic contamination. In that state it not only fails to extract or filter the impurities of water passing through it, but adds to the quantity of pollution. Further, the solvent power of the water enables it to take up many substances from the soils and rocks through which it flows. It therefore frequently happens that wells in farm yards, and especially in cities are contaminated and the water rendered unwholesome to drink. This means of contamination has often been productive of serious and even fatal diseases and shows the propriety of preventing the accumulation of refuse, and where it is unavoidable, of placing it at the greatest distance from wells used for drinking purposes." The processes of oxidation of organic substances treated in the above extract from Johnson's "How Plants Feed" explains the probable reason why the well surrounded by poor conditions, and situated in a grass covered lawn yielded high chlorine figures and yet was practically free of organic impurity, as shown by sanitary analysis.

Following is a description of Champaign and Urbana with reference to size, population, drainage basin and sewage systems.

Champaign is a rapidly growing city, having a population of about 2500 inhabitants. It is situated in a drainage basin of 2400 acres and is outlined by city limits enclosing something over 1200 acres. Of these 1200 acres 1000 are in the residence portion, while about 120 acres are covered by business blocks. The surface of Champaign is rolling, sloping east and south at an average of slope of about  $1\frac{1}{2}$  ft per 100 ft. There are natural drainage basins each drained by a small creek. The first rises in the southwest corner of the city and flows east and north and into the River at Green and Third Streets. The second rises at the west end of West White Street and flows eastward to the intersection of



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Second Street and Springfield Avenue where it enters the Bonevard. The Bonevard, the largest of the three streets rises in the northwest part of the city and flows east and south crossing at Wright Street, between Hooley and Green Sts., into Urbana. The above data were obtained from City Engineer Warrant of Champaign.

Champaign has about 24 miles of sewers and is fairly well supplied with sewers excepting in the extreme northwest parts and north of Park St., on the east side.

The following was learned from J. Rover, City Engineer of Urbana, concerning population, drainage, sewage and acreage of that city. It has a population of something near 6000 inhabitants. There are 1200 acres included within the city limits, out of 1500 acres of drainage basin. 980 acres are included in the residence portion while 50 acres are covered by stores and other business blocks. The surface is rolling and slopes toward the south fork of Salt Creek. Sewage system is not as efficient as that of Champaign. The west part of town has practically a complete sewage system from Race to Wright Streets. North of West Main Street is not well supplied with sewers and there are none in the east part of the town.

J.E. Vallinor, in a thesis written at the University of Illinois in 1904 on the well waters of Champaign and Urbana, gave <sup>a</sup> rather extensive description of the soils of Champaign and Urbana, particular reference being made to the strata from which the well water of ~~these~~ cities are obtained.

Following is an extract from his paper: "The cities are situated in the drift of central Illinois, and rest upon the crest of one of the long terminal moraines, which in this part of the state, extend from north west to south east and which determine a very <sup>part</sup> important <sup>a</sup> in connection with natural drainage. The drift as stated by Bradley (48 p., 27) is 197ft in thickness. With reference to its water bearing strata it may be divided into three distinct parts. At the surface is a bed of soil, yellow clay and sand 15 to 17 feet thick. These layers shade into one another, but usually they can be readily distinguished. In some parts, as at the corner of Neely and Third streets, the yellow clay contains a large admixture of sand and gravel. This bed is quite pervious to water, and resting as it does on the almost impervious bed of blue clay that portion of the storm water which sinks into the ground accumulates in the lower part of it. This is the source of the water obtained from shallow wells dug down to blue clay, or reaches a short distance into it.

The crest of the moraine before mentioned is such a low sandy and gravelly ridge either of its sides, and at different places in it small banks have been opened up. It is not positively known that these banks are the out-



grounding of layers of sand and gravel which dip to some depth beneath the surface, but some of them probably are. A fact indicating that there are at least some superficial layers, is that upon both sides of the mountains, at some distance from the coast, small springs are found.

The second part is on an immense bed of blue clay, lying just beneath the bed of soil, clay and gravel, varying in thickness from 45 to 90 feet and containing within it beds of sand, apparently distributed and usually water bearing. The blue clay itself, is almost impervious to water, and, while some of the water in the beds of sand may have reached them by slow percolation through the clay, it is quite probable that most of it enters the beds at outcroppings upon the surface. When a tubular well is put down to one of these beds the water obtained is almost certainly that of the bed alone, but when a well is dug down to one, the water is a mixture of that of the deep bed and that of the stratum lying just <sup>above</sup> the blue clay. Sometimes the surface of a well is cemented from its surface down to the blue clay with the intention of keeping out the water of this upper stratum, but that the <sup>method is</sup> successful is very doubtful.

The third consists of the old soil with the underlying stratified clays and sands. It begins at a depth below the surface varying from 70 to 90 feet, and extends to the bottom of the drift. Nearly all of the deep wells of this region derive their water from the sands of this division, but at what remote place the water enters the sand is not known. Certain it is that the thick bed of blue clay must form an almost impassable barrier to the passage of the storm water downward to these sands, and this fact added to the fact that the ~~sands~~ contain immense quantities of water, makes it necessary to seek some place remote from here as its place of entrance.

The point to which special attention is called are:

1. The part of the storm water which sinks into the ground within the city limits is amply sufficient to supply the inhabitants with water.
2. This water sinks almost directly into the ground and quickly finds its way into the shallow wells.
3. The water of the tubular well in the blue clay is derived from the storm water which enters the bed of sand at some point probably <sup>remote</sup> from the well, while that of the dug well is probably a mixture of the water just mentioned and that found near the surface.
4. The water of the tubular well reaching below the old soil is derived from storm water reaching the beds of sand in some unknown manner, but certainly at a place quite distant from the well."



The above extract explains readily the reasons for shallow wells in this vicinity giving greater evidence for contamination than those sunk below the bed of blue clay, and fitted with pipes. Frequent reference will be made in the discussion of results of examinations made to the above description of strata.



## OBJECT AND DISCUSSION OF RESULTS.

The object of this thesis is to determine the chlorine content of the well waters of Champaign and Urbana, with an attempt to show the variations due to the depth and external or surface sanitary conditions. With this end in view samples have been taken from over two hundred wells ranging in depth from 8 feet to 205 feet, from wells whose surroundings <sup>well</sup> from a sanitary standpoint are the worst possible, to those of the tubular having a depth of 200 feet or more. The work was begun in the fall of 1900, but, owing to the difficulty and inconvenience of securing samples from wells during the inclement weather of winter, only about <sup>30</sup> examinations were made during the fall months - the rest have been done in February, March, April and May of 1901 - the rest of them during the latter part of March, and all of April. Extreme <sup>care</sup> has been exercised to observe all surroundings and means of possible contamination, such as depth, slope of surface, proximity of barns, privy vaults or cesspools, presence or absence of organic waste matter near the surface, kind of pump and cover, and, last and probably ~~the~~ most important of all, whether dug or tubular. The examination of waters of different depths has served admirably to prove assumptions concerning normal and abnormal chlorine.

On East Park Street, Champaign two tubular wells, one of them 82 feet deep and the other over 100 feet deep contained only a trace of chlorine while a shallow dug well just across the street from them and presenting surroundings as good as the average showed a chlorine content of 86 parts per million. The above difference in evident contamination is undoubtedly due to the different sanitary conditions attendant on the difference of depth, the fact that the tubular wells were such and on the difference in chances of contamination at the different depths, consequent on the variations in stratifying of the earth as described above in the extract from J.E. Hallinan's "Well waters of Champaign and vicinity."

I find that in portions of the city where there is no sewerage system that the chlorine content is much greater in wells presenting the same general surroundings and having the same depth as those in the vicinity of sewers, proving again the difference between normal and abnormal chlorine, and establishing the fact that the high chlorine content is abnormal. Privy vaults, cess-pools, sink drains of course are very few in number in portions of the city supplied with sewers, barns being about the only agent of contamination, excepting when sewers are not used.



## METHOD.

The method used for the estimation of chlorine in this work is one used by Mohr and is generally considered the simplest, most expeditious, and best of a number of methods. It consists in titration of water with a standard solution of silver nitrate ( $\text{AgNO}_3$ ) made up of 2.8944 grs., per litre of water; which is of such a strength that when 50 cc. samples of water are taken 1 cc. of the standard solution represents 1 part of Cl per million parts of water. The  $\text{AgNO}_3$  when added to the water causes a precipitate of white silver chloride ( $\text{AgCl}$ ) to form. In order to arrive at the end reaction (or discover when all the chlorine has been combined with silver of  $\text{AgNO}_3$  solution) an indicator of potassium chromate is used, which is made in the following manner:—approximately 50 grs. of potassium chromate are dissolved in 1 litre of water and any chlorine present precipitated by silver nitrate solution. The clear liquid is decanted off as chlorine free.—1 cc of this indicator is used for 50 cc of water.

The potassium chromate present does not affect the titration as long as any chlorine is present, for chlorine has a greater affinity for silver than has the chromate, but the instant all the chlorine has been taken up red silver chromate is formed by the action of potassium chromate on the excess of silver nitrate. The first few drops of silver nitrate serve only to generate a dirty color because of the small amount of silver chromate in a comparatively large quantity of water. The eye trained in this operation, however, can readily detect the end reaction—a dirty color. Duplicates were run, the first of them being prepared for a blank by adding a drop of ammonium chloride solution to the titrated sample, thus titrating back the small amount of silver chromate found, and leaving the quantity of silver chloride to titrate against. This method is much more accurate if performed by light of gas lamp because of greater delicacy of shades of color.



### TABLEATION OF RESULTS.

Note:-

Welled= An open dug well welled up with local  
water. Driven well with tightly closed iron tube extending to  
bottom of well.  
That in column for depth indicates shallow welled well



Urbana

Date	Location of Well	Depth	Depth	Reputation	Condition of Well	11	Pgs Miller	11
Nov	1107 W. Illinois	Dug	50	Good	Surroundings good		2.4	
	915 " "	"	40	Very Good	Fair surroundings		33.5	
	815 " "	Walled	60	Suspicioned	Very good		11.	
	" "	"	45	Satisfactory	Good surroundings		48.	
	711 " "	"	45	Good	Medium		16.	
	706 " "	"	25	"	Very Good		5.35	
	712 " "	"		Not Good	Nothing bad visible		38.	
	" "	"	42	Good	Nothing unusual		5.	
	406 " "	Tubular	40	"	Very Good		10.	
	810 " "	Cistern					22.	
	900 S. Bussey	Walled	27	Good	Out house near		11.	
	707 1/2 W. California	Tubular	50	"	Good conditions		4 Trace	
	609 W. High	"	50	"	Out-house rather close		13.	
	504 W. Illinois	"	65	"	Good		13.	
	" "	"	40	"	Nothing unusual		15.	
Dec	407 " "	"	45	Very Fair	Very Good		22.5	
	464 " "	Tubular	50	Satisfactory	Fine Surroundings		16.	
Dec. 15/10	South of Urbana	Dug	18	Good	75 yds. out in fiddle		5.	
"	" Near above	Walled	18	"	Earth littered		10.	
"	" South of "	Tubular	28	"	Nothing objectionable		.8	
"	" Near "	"	35		Out-house near		4.2	
"	" Near above - East	"	25		Appearance fair		4.8	
"	" " " " "	"	35	Unknown	Average		2.7	
"	" Tile drain - Lin. Ave				From a field		.8	
"	" Test Well - Uni.				In grass field		1.4	
"	"							



# Champaign: Ill.

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Date	Location of Well	Kind	Depth	Reputation	Condition of Well	Pay to Million
Jan 26/1900	S. Wright St.	Tubular	—	Condemned	Out-house 60' away	8.85
" "	E. Daniel St.	Dug	27	Satisfactory	Slops near cover of well	4.1
" "	306 E Daniel St.	Walled	190	Good	—	3.5
" "	411 " " "	Walled	22	Very Good	Denuded vegetation near	2.2
" "	511 " John "	Tubular	—	Suspicioned	Large grass lawn	7.5
" "	Corner John & Fourth	Walled	—	Good	Barn - 60 ft away	10.5
" "	511 E. Green	Tubular	—	Excellent	Dairy across the street.	536.5?
Feb 11/1900	6 Blks. S. Neil St.	Walled	—	Considered good	Bad pump and good surroundings	40.5
" "	" " " " across St	"	—	—	Situated well. - wood pump	25
" "	1 " " " "	"	—	Very Good	Poor cover - otherwise good	51.
" "	7 " " "	"	35	Good	Better than average	20.5
" "	Chas. St. near State	"	35	Excellent	Untidy back yard	34.5
" "	Cor. Randolph Chas.	"	40	"	Fine surroundings	.8
" "	627. S. Randolph	"	40	Considered good	Surrounded by rubbish.	15.0
" "	600 " " West Side	"	25	"	Decidedly bad	12.5
" "	W. Williams St	"	40	—	Out-house 25 yds.	9.5
" "	500 S. State St.	"	—	Excellent	Iron pump - Good	8.
" "	600 " " "	"	30	Suspicioned	Appearances good	51.
" "	500 S. near Randolph	"	—	Good tasting	Pump and cover good	43.
Feb 23/1900	End Green St - West,	"	50+	Unknown	Top of hill - Excellent	8.5
" "	7 Blks. West Green	"	25	Good	Wooden pump - Good	57.
" "	5 " " "	Tubular	180	Good	Excellent	2.
" "	400 " " "	Walled.	30	Thought fine	Surroundings appear good	34.
" "	3 Blk. W. Green St.	"	—	Typhoid	Under house	42.
" "	2 " " " "	"	—	Could not learn	In low place - Sloppy	30.5
" "	167 " " " "	"	20	Good drinking	Poor pump and cover	25.5
" "	137 " E. Green "	"	17	—	Higher than outhouses	90.5
" "	208 E. Stoughton St.	"	30	Considered Good	Sloping grass lawn - Good	33.



# Champaign, Ill.

Date	Location of Well	Kind	Depth	Reputation	Condition of Well	Prs. per Million. 15
April 1, 1900	609 W. Springfield	Tubular	190'	Good	Very good.	4.
" "	Corn. Spring $\frac{1}{2}$ Linn.	Walled.	22'	Bad.	No pump - unused.	32.5
" "	407 W. Uni. Ave	"	27'	Suspicioned	Iron pump in chicken yard	82.
" "	403 E. State St.	"	40'	Good.	In grass lawn - not bad.	24.
" "	209 W. Springfield	"	—	—	Privy vault 20 yds.	124.
" "	107 " "	"	30'	Good.	" " $\frac{1}{2}$ barn 30 ft.	81.5
" "	31 E " "	"	15'	"	Poor cover - dirty yard.	131.
" "	14 " Healey.	"	—	Unknown	Better than average	38
" "	22 " "	"	19'	Rented.	Very bad. privy $\frac{1}{2}$ barn near	28.
" "	106 " "	"	—	Good.	Nothing unusual - privy near	103.
" "	200 " "	"	30'	"	Iron pump - good surface	34.5
May 17, 1900	34 Sec. South	"	—	Unlearned	Everything bad.	44.
" "	23 S. Locust St.	"	—	Good.	Sloppy yard - privy vault 30 ft	63.
" "	24 " " "	"	28'	"	Chain pump - top of knoll.	52.
" "	40 Sec. South.	"	20'	"	In low ground.	116.5
" "	102 E. White	"	—	"	Slops near pump.	104.5
" "	204 " "	"	—	"	Questionable - filthy	24.
" "	306 " "	"	18'	"	Chain pump - Low ground	46.5
" "	402 " "	"	16'	"	Fair surroundings	108.5
" "	504 " "	"	—	"	Good but low.	159.
" "	602 " "	Tubular	40' +	"	Top of knoll - barn near	24.5
April 15, 1900	207 " Hill St.	Walled.	—	Unknown.	No contam. agents seen	160.
" "	111 " "	"	—	"	Privy vault 100 ft.	33.
" "	110 " "	Tubular	35'	Good - new	Nothing bad near.	11.
" "	204 " "	Walled	27'	Good.	Neat $\frac{1}{2}$ clean surroundings	75.
" "	304 " "	"	20'	"	Rather lower than barn	160.
" "	305 " "	"	31'	Fair.	Normal surroundings	82.5
" "	401 " "	"	20'	Good.	Better not described.	134.

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# Champaign Ill.

Date	Location of Well	Kind	Depth	Reputation	Condition of Well	Per Million
April 5 <sup>th</sup>	406 E. Hill St.	Walled	30'	Typhoid ?	Lower than privy vault.	58
" "	306 N. Fifth	"	—	Good	Chain pump - poor cover	189.
" "	511 W. Washington	"	—	Unknown	Stops from kitchen near	182.
" "	601. " "	"	35'	Thought Good	Privy vault 60 ft.	49.
" "	308 N. Sixth	"	15'	Good.	Low, filthy, back-yard,	91.
" "	207 W. Park	"	—	"	Good condition.	108
May 13	W. Uni. Ave 700	"	22'	—	Barn 25'. Clean	27.
" 11	839 W. Church	"	—	Good	Splendid surroundings	14.
" "	823 " "	"	13'	Suspicioned	Dirty yard Privy vault near	74.
" "	807 " "	"	15'	Good	Sink drain 20' away	27.
" "	715 " "	"	Deep	"	Very good - nothing near	18.
" "	611 " "	"	Not deep	Unused?	Excellent surroundings	61.
" "	312 " "	Tubular	60' +	Good ?	No barn or privy vault near	18
" "	209 " "	Walled	18'	Unused?	Sink drain 40' away	45.
" "	108 " "	Tubular	40' +	Good	Very Good	8.
" "	109 " Hill St	Walled	25'	Unknown	Seemingly Good.	226.1
" "	311 " " "	"	30' +	Unused	Near Garden - Fair	79.
" "	307 W. Prairie	"	25'	Unknown	Privy near, in bad con.	132.
" "	628 " Hill	Tubular	205'	New well	Good.	3.
" "	632 " "	Walled	20' +	Good	Water drains into well	150.
" "	306 " Vine	"	15'	"	Cess-pool 20' away.	26.5
" "	312 " "	"	—	"	Fair surroundings	24.5
" "	224 " Maple	"	23'	"	Barn 10' - cess-pool near	34.5
" "	208 " "	"	Deep	New well.	Fine surroundings	40.0
" "	308 W. Tremont	Walled	—	Unknown	Better than average.	26.5
" "	210 " "	Tubular	40	Good	Very good - nothing near	32.
" "	208 " "	Walled	—	Suspicioned	In low part of lot	18.
" "	206 " "	"	18 1/2	New well	Privy vault higher - 25 yds	19.



# Champaign Ill.

Date	Location of Well	Kind	Depth	Reputation	Condition of Well	Per 7.5 million
Feb 25, 1900	102 E Springfield	Walled.	—	—	Out-house near	63.0
"	26 " "	"	11	Said to be good	Privy vault near - slops	140.
"	416 " "	"	60	Suspicioned	Underneath house - bad	104.5
"	35 Third South	"	12	Unknown	Filthy back-yard.	42.
"	107 E. Stoughton	"	30	"	Poor cover - dirty yard	47.5
"	30 S. Locust St.	"	—	Nothing bad	Surface water supply	114.5
"	206 E. Stoughton	"	22	Excellent	First class appearance	51.5
"	402 E. " "	"	60	—	Chain pump - too low	69.5
"	502 " "	"	16	Unused.	Poor cover and pump	79.
"	602 " "	"	33	Could not learn	Iron pump - Out-house near	83.
Mar 14, 1900	302 " Healey St.	Tubular	38	Best possible	Privy vault & barn near	34.5
"	301 " Stoughton	Walled	20	Nothing bad	Slops near cover	37.5
"	502 E. Healey St.	"	25	Good	Better than average	44.
"	522 Springfield	"	—	"	Wretched surroundings	112.
"	601 E Stoughton	"	22	Thought good	Out-house rather close	56.5
"	603 " Healey	"	24	—	In sunken place in yard	48.5
Mar 24	306 " Clark	"	—	Good	Bad cover - otherwise good	30.
"	209 " Uni. Ave	"	25	Splendid	Good surroundings	79
"	123 " " "	"	30	Good	Privy vault 40 ft.	111.
"	N 91 Locust St.	"	14	Nothing bad	Lower than kitchen door	42.5
"	15 - Water " "	"	12	Good	Back-yard filthy.	132.
"	201 - N. First St.	"	—	"	Privy-vault - 25 ft.	178.
"	112 - E Park	"	Deep	"	Nothing objectionable	81.
"	206 - " "	"	shallow	Suspicioned	Condition above average	86.
"	409 " "	Tubular	Deep	Good	Perfect	Trace
"	506 " "	"	82	"	"	Trace
"	604 " Clark	Walled	20	"	In low ground - bad	92.5
Apr. 3	810 W. Healey	Tubular	60	"	On top of hill - Good	4.



# Champaign Ill.

Date	Location of Well	Kind	Depth	Reputation	Condition of Well	Pts. Million
May 13	207 W. Everett	Walled	Deep	Good	Exceptionally Good	24.
" "	303 " "	Tubular	Not deep	"	High part of lot	67.0
" "	311 " "	Walled	30'	Not learned	Cess-pools & other slops near	32.5
" "	801 N. State St	Tubular	Deep	Could not learn	Excellent surroundings	Trace
" "	42 N. Randolph	Walled	35'	Good	Every-thing clean	5.
" "	609 " Hickory	"	—	"	Very good	42.
" "	507 " "	"	22'	"	In porch - very good	96.
" "	81 " Walnut	"	—	"	Seemingly good.	69.
" "	76 W. Washington	"	Deep	"	Very fair - bath a little close	62.
" "	105 " "	"	12'	Unknown	Fair surroundings	64.
" "	416 N. State St.	"	—	Considered good	Generally bad - much filth	141.
" "	407 " " "	"	—	Suspected	Above normal - Privy vault 50'	92.
" "	407 " Prairie	"	40'	Good	Good	31.
" "	426 N. Elm St.	"	—	Could not learn	Very Good	27.
" "	505 W. Washington	"	Deep	Good	Privy vault 20 yds - Fair	109.
" "	311 " "	"	40'	"	Very fair - low	118.
" "	523 " Columbia	"	25'	Satisfactory	Bath and privy near	75.
" "	411 " "	Tubular	Deep	Good	About normal	3.
" "	401 " "	"	"	"	Good	4.
" "	303 " "	Walled	17'	Condemned	Nothing unusual	60.
" "	205 " "	"	15'	Good	Sloppy back-yard	97.
" "	111 " "	"	Deep	"	Better than average	52.
" "	510 N. Neil St	"	—	"	Privy vault 40 ft.	36.
" "	37 N. Hickory	"	12'	"	No pump - abominable	63.
" "	109 N. Market	"	—	"	low ground - surface water	200.
" "	106 W. Vine	"	11'	"	Fine surroundings	22.
" "	703 N. Randolph	"	—	Unknown	Privy-vault 40 ft.	84.
" "	15 N. Market	"	15'	"	Not good	36.



## Champaign, Ill.

Date	Location of Well	Kind	Depth	Reputation	Condition of Well	Pro. Million
May 13.	100 S. State St.	Walled	20'	Good	Very fair	40.
"	308 W. Clark "	"	—	Unknown	Chain pump - Good	22.
" 10	406 " " "	"	25'	Good	Very fair conditions	65.
"	510 " " "	"	Deep	—	Iron pump - Not good	75.
"	603 " " "	Tubular	Not Deep	Suspicioned	Very good surface	65.
"	604 " " "	Walled	33'	Unused	Very bad - privy near	50.0
"	616 1/2 " " "	"	20'	"	Near barn - Side hill	76.5
"	Cor. Prospect & Uni.	"	35'	Considered good	Good	19.5
"	108 W. University Ave	"	Deep	Unknown	Chain pump - Good	73.5
April 27	511 N. Ash St	"	—	Good	Flat ground - Slope near	30.5
"	106 " " "	"	32'	"	Slope all about surface	126.
"	201 " " "	"	22'	"	On Knoll - Very good	10.
"	601 " Poplar St	"	—	—	Average - Privy lower	38.
"	512 " " "	"	40'	—	low - much filth about	175.
"	602 " " "	"	35'	Good	Appeared good	69.
"	406 " Columbia	"	30'	"	Clean yard - Barn lower	41.5
"	501 " Fifth St.	"	20'	"	Porous, sandy earth	132.
"	501 " Columbia	"	32'	Unknown	Poor cover - otherwise good	36.5
"	506 " " "	"	—	Good	Iron pump - not good	137.5
"	604 East. " "	"	32'	"	Average surroundings	38.
May 25	Mile. S.W. of Champaign	"	12	"	Top of Hill - privy 45' away	10.5
"	W. of Champaign 1/2 mi	Tubular	50+	"	Privy vault higher	2.
"	3 mi. N.W. of Cham.	Walled	Not Deep	"	At farm house - Good	19.



## CONCLUSION.

Having made determinations of the content of chlorine in several hundred waters from the wells of Chicago, Urbana and vicinity, I have arrived at the following conclusion. That in nearly every instance where a well is surrounded by contaminating agencies, the water in said well is polluted. The greatest agents of pollution so far as I was able to discover are privy vaults, which are placed in close proximity to the wells. Sewer pools, sink drains and barns follow in the order named, regarding their effect towards producing contamination in waters. A fact which was very noticeable, is that tubular <sup>wells</sup> ranging from 90 to 200 feet in depth are not affected by agencies of pollution and no matter where situated such wells show good evidence of purity. Tubular wells of shallow depth, which as a rule are in a better state of purity than open wells, show, in many instances evidence of contamination when surrounded by polluting agencies. It is a noticeable fact that all of the cased and shallow tubular wells situated in portions of the cities which have no drainage system are in a worse state of contamination than are similar wells located in areas which are drained by sewers. In parts of the cities where no <sup>large</sup> system is present, cased wells are in the greatest abundance, and in nearly every instance, such wells are in bad state of pollution.





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